

## WINDOW ANTENNAS

### INCORPORATION BY REFERENCE

[0001] An Application Data Sheet is filed concurrently with this specification as part of the present application. Each application that the present application claims benefit of or priority to as identified in the concurrently filed Application Data Sheet is incorporated by reference herein in its entirety and for all purposes.

### TECHNICAL FIELD

[0002] This disclosure relates generally to electrochromic devices, which may be used in electrochromic windows for buildings or other structures.

### BACKGROUND

[0003] Electrochromism is a phenomenon in which a material exhibits a reversible electrochemically-mediated change in one or more optical properties when stimulated to a different electronic state. Electrochromic materials, and the devices made from them, may be incorporated into, for example, windows for home, commercial, or other uses. The color, transmittance, absorbance, or reflectance of such electrochromic windows can be changed by inducing a change in the electrochromic material, for example, by applying a voltage across the electrochromic material. Such capabilities can allow for control over the intensities of various wavelengths of light that may pass through the window. For example, a first voltage applied to an electrochromic device of the window may cause the window to darken while a second voltage may cause the window to lighten.

[0004] Electrochromic devices, like most controllable optically-switchable devices, contain electrical connections for controlling the application of electrical stimulus (for example, in the form of a controlled applied voltage and/or current) to drive optical transitions and/or to maintain optical states. Electrochromic devices are frequently implemented as very thin layers that cover the face of a surface such as a window surface. Such devices typically include transparent conductors, often in the form of one or more layers that cover electrochromic electrodes and distribute applied voltage over the face of the device to effect a complete and efficient optical transmission.

### SUMMARY

[0005] One aspect of the disclosure pertains to a window antenna characterized by the following features: (a) a window having one or more lites, each comprising at least two surfaces having regions configured for viewing through the window; (b) an electrochromic device disposed on a first surface of the window; (c) an antenna structure disposed on the first surface or a second surface of the window; and (d) a ground plane disposed on the first surface of the window, the second surface of the window, a third surface of the window, or a structure connected to the window. In certain embodiments, the lite has a length or width that is at least about 60 inches. In certain embodiments, the electrochromic device does not have an ion conductor deposited between electrochromic and counter electrode layers.

[0006] The antenna structure may have various configurations such as a strip line or a patch. In certain embodiments, the strip line or patch structure may serve as part of

a monopole antenna. In one such embodiment, a strip line has an axis along its length and the ground plane is substantially perpendicular to the axis of the strip line. Such ground plane is disposed on the same surface as the antenna structure or disposed on a structure connected to the window. In certain embodiments, a strip line has an axis along its length and the ground plane is substantially parallel to the axis of the strip line. The ground plane may be provided on a different plane than the strip line, e.g., on a different surface of a window lite. In certain embodiments, the antenna structure includes a two strip lines, where the strip lines are configured as a dipole antenna. In some embodiments, the two strip lines are substantially parallel. Unless otherwise stated herein, all references to a strip line can be replaced with references to a patch.

[0007] In certain embodiments, the antenna structure comprises a fractal structure. In one example, the fractal structure is disposed on a plane and wherein the ground plane is substantially perpendicular to the plane of the fractal structure. In some such examples, the ground plane is disposed on the same surface as the antenna structure. In some such examples, the ground plane is disposed on a structure connected to the window. In certain embodiments, the fractal structure is disposed on a plane and the ground plane is substantially parallel to the plane of the fractal structure (e.g., located on a separate surface).

[0008] In certain embodiments, the antenna structure is configured as a dipole antenna such as a Yagi antenna or a log periodic antenna.

[0009] In some implementations, the window antenna additionally includes an antenna controller. In some cases, the antenna controller is disposed on the window. In certain embodiments, the antenna controller includes a transmitter and/or receiver for the antenna structure. In some implementations, the window antenna additionally includes a window controller configured to control optical transitions of the electrochromic device. In some cases, the window controller and the antenna controller are disposed in a single carrier and/or enclosure.

[0010] Another aspect of the disclosure pertains to a system including: (i) a plurality of window antennas as described in any of the embodiments presented herein; (ii) a plurality of controllers each configured to: (A) drive the electrochromic devices, and (B) drive the at least one antenna structure in each of the window antennas; and (iii) a network controller for providing instructions to the plurality of controllers.

[0011] Another aspect of the disclosure pertains to an insulated glass unit (IGU) that may be characterized by the following features: (a) two or more lites, each having at least two surfaces with a region configured for viewing through the IGU; (b) a spacer separating the lites from one another, where the spacer is provided proximate perimeter regions of the lites; (c) an antenna structure disposed on a surface of a lite, the spacer, or an electrical connector on the IGU; and (d) a ground plane disposed on the IGU or a frame structure in which the IGU is mounted. In certain embodiments, at least one lite of the IGU has a length or width that is at least about 60 inches.

[0012] In the IGU, the antenna structure may have various configurations such as a strip line or a patch. In certain embodiments, the strip line or patch structure may serve as part of a monopole antenna. In one such embodiment, a strip line has an axis along its length and the ground plane is